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THE HOT DRY SUMMER OF 1959

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Note. Any correspondence arising out of this special edition of Entopath should be directed to the Chief Research Officer and not, as is usual, to the Entomologist or Pathologist.

THE HOT DRY SUMMER OF 1959

INTRODUCTION

It would have been a pity to have let the summer of 1959 pass into meteorological history without some effort to record its more obvious effects on our forests. In case we have all forgotten it, the following brief description (by A.I. Johnson in the periodical "Weather") will remind us of the main features of that very remarkable summer.

" ..... taking England and Wales as a whole, the period from May t September was drier than in any of the last 200 years, although there we one or two thundery periods with locally heavy rain.

In Northern and Western districts of Scotland, the summer was less outstanding than elsewhere, because in June and July depressions moving north-east between Iceland and Scotland gave some heavy falls of rain.

Apart from some areas of Scotland in July, sunshine amounts were above average throughout the summer everywhere in Britain.

Of the individual months only September could be considered exceptional; this was on account of its extreme dryness which in England and Wales has not been equalled since comparable records began in 1870, and possibly not since 1754. The most settled part of the summer was fro middle of August to the end of September, when during this time in some places in eastern England received no measurable rain at all.

Despite the widespread dryness of the summer, there were occasions when weak rain belts crossed the country, giving slight rain in most place and there was also quite a lot of thundery activity. The number of days when thunder occurred was greatest in June and July at most places, althou some of the most violent storms of the summer developed over southern England during the three days from 9th to 11th August.

Near the end of June a small depression moved across the British Isles, ... almost a month later between the 27th and 29th July weather was very unsettled as a depression moved across England ..... and there were westerlies over Scotland for the first week of August. On the 13th and 14th August an unusually deep depression for the time of year moved north off the Irish and Scottish coasts, and associated fronts brought some rain to most parts of Britain, with gales near the western coasts. For the next few weeks there were only one or two minor interruptions in the fine weather.

It was mid-October before the anticyclone regime finally came to an end."

A questionnaire was sent out in December 1959 to all Commission forests in order to collect observations, comments and opinions, on the effects of the summer in all parts of the country. The chief Forester, Ministry of Agriculture, Northern Ireland, kindly agreed to collaborate in this survey, and some 60 returns were made by foresters in Northern Ireland. Questionnaires were also sent to certain private forest estates in Britain. It has been found convenient to base all tables on the returns made from State forests, as these comprised a very large and widespread sampling of the country. Returns from private estates were however, carefully scrutinised and were found to be closely in line with those from Commission forests. Besides the information obtained from the questionnaire, a number of observations made by members of the Research Branch have been included. The returns (673 in all) were very ably analysed by the late C.P. Kirkland, (Forestry Commission, Research Branch) and this note is based on his report.

Thanks are due to all those who returned questionnaires, and apologies are due to them also for the delay in showing them what we have made of their information. It is likely that the reader will think that the conclusions are rather negative, this is not however unimportant, since it was a most unusual summer, and it is comforting that on the whole our forests came through without too many disasters. There are however, a few positive results of interest as well.

Acknowledgements are also due to the Meteorological Office for weather data from published records, and more especially for the supply of estimates of potential evaporation (The latter were prepared by the simplified method described in Technical Bulletin No.4. of the Ministry of Agriculture, Fisheries and Food.)

In order to relate the behaviour of trees and other events to the actual weather experienced it would, of course, have been useful to have had rainfall records for all forests reporting. Since these were only available in a minority of cases, estimates for the rainfall of regions, (counties and Conservancies) have been made by averaging the records from appropriate type stations. These are presented in Appendices I and II, and for added interest comparative figures for the very contrasting summer of 1958 have also been given, together with the long term averages, and as it is an advantage to consider rainfall in relation to evaporation, estimates of potential evaporation have also been presented.

* Potential evaporation is the amount that 'well watered' vegetation would evaporate under given climatic conditions. It is measured, like rainfall, in inches.

It is of interest to contrast the main features of the weather of 1 and 1958. The following summary of temperature and rainfall in the two years is taken from the Annual Summary of the Monthly Weather Bulletin issued by the Meteorological office:

Monthly rainfall as % of the mean for period 1916-50

		Mar	Apl	May	June	July	Aug	Sept	Oct	Nov
1959	England & Wales	114	130	44	81	83	44	11	92	123
	Scotland	91	125	53	112	122	51	37	106	139
	Northern Ireland	123	122	50	87	102	35	47	122	110

Deviation of monthly mean temperature (F°) from 1921-50 mea

England & Wales	+2.4	+2.2	+2.1	+1.4	+1.8	+2.6	+2.5	+4.2	+1.0
Scotland	+2.4	+1.8	+2.9	+1.6	+1.1	+2.6	+2.4	+4.5	+1.9
Northern Ireland	+2.5	+1.1	+2.9	+1.7	+1.3	+2.4	+2.1	+4.3	+0.5

Monthly rainfall as % of the mean for period 1916-50

1958	England & Wales	83	51	132	202	117	123	158	88	58
	Scotland	86	77	132	102	120	113	93	81	39
	Northern Ireland	87	63	108	192	128	123	113	72	59

Deviation of monthly mean temperature (F°) from 1921-50 mean

England & Wales	-4.0	-1.5	+0.1	-1.1	-0.7	0.0	+2.2	+1.3	+0.1
Scotland	-4.4	-0.2	-1.3	-0.3	0.0	+0.3	+3.4	+2.1	+1.4
Northern Ireland	-4.0	-0.3	-1.5	-0.9	+0.2	+0.1	+3.2	+1.8	+2.3

1958 had a cold dry spring and a wet summer. 1959 had a warm spring with above average rainfall, and a very warm summer, exceptionally dry in much of England. Further meteorological details will be found in Appendice I, II and III.

PLANTING LOSSES

Foresters planting 10 acres or more of any of the nine principal species, were asked to record losses of 25% or greater on any area exceeding 5 acres, and to give additional information about possible contributing factors other than drought. The figure of 25% is somewhat arbitrary; it is however a considerable level of loss usually calling for some degree of beating-up in the subsequent season.

Table 1 summarises the losses of each of the nine species included in the questionnaire, recording only the losses of 25% or more attributed by foresters to drought.

TABLE 1

Area on which losses of 25% or more were reported, as % of area planted.

	SS	NS	SP	CP	PC	JL	DF	Ts	Be	All Species
ENGLAND	1.8	15	4.4	20	1.8	24	16	25	16	10.9
WALES	0.2	0	4.5	21	4.8	1.7	23	19	7.8	4.4
N.IRELAND	1.0	0	0	-	3.3	0	0	1.5	0	1.3
SCOTLAND	0.4	0	0.8	28	1.2	1.9	2.2	0	0	1.2

If we call losses of 25% or more 'serious', then serious losses were rare in Scotland and Northern Ireland. Only the small acreage planted with Corsican pine suffered badly in Scotland, accounting for 38% of the area subject to serious loss. Most of the losses of Corsican pine were on dune sites. Generally in both Scotland and Northern Ireland it was a good planting year. 76% of the area subject to serious loss in Scotland was in South Scotland.

In Wales it was also generally a good planting year, though Douglas fir and Western hemlock sustained serious losses on small areas. This was thought to be largely due to the use of over-size plants of Douglas fir with poor root-systems, and in the case of Western hemlock, to some infection of planting stock with Botrytis. Corsican pine also showed heavy losses, though largely confined to one dune area in South Wales.

England experienced the most serious losses, East and (to a lesser extent) South-east England being the Conservancies most affected. This is in accord with the pattern of the drought, and therefore much what one would expect. Table 2 makes this rather clearer. Losses (expressed as the percentage of the area planted suffering losses exceeding 25%) have been set against the summer rainfall for six commonly planted species. The spruces have been left out because they tend to be planted on moist soils. It will be noticed that the order of loss does accord reasonably closely with the amount of summer rainfall.

TABLE 2

Growing Season Rainfall and Planting Losses

(S.P., C.P., P.C., J.L., D.F., Ts. Grouped)

Conservancy	May - Sept Rainfall inclusive (ins)	Percentage of planting area suffering losses of 25% or over
W.(Scotland)	18.2	0.0
N.(Scotland)	17.1	0.5
S.(Scotland)	11.3	6.5
N.(Wales)	11.2	13.5
S.(Wales)	9.8	8.2
N.W.(England)	8.6	12.1
E.(Scotland)	8.3	1.0
S.W.(England)	7.0	11.3
N.E.(England)	6.8	6.0
New	6.3	10.1
Dean	6.1	14.0
E.(England)	5.0	25.3

It is interesting to see whether there has been any obvious tendency in the past to high planting losses in dry seasons. A simple indication of planting losses is the number of plants used in beating-up in the subsequent season. National figures for beating-up (all species) have been plotted against a very crude expression of the dryness of the previous season - merely the number of months in the growing season with rainfall below average. Figure 1 shows this for England and Wales, and Figure 2 for Scotland, for the planting seasons 1948 to 1959 inclusive. It is pretty clear that in England and Wales losses are related to the dryness of the previous growing season, but the relationship is not nearly so obvious in Scotland, if indeed it exists. In all probability this is due to the lesser evaporation rates in the north where growing season rainfall is less important in providing the necessary moisture for survival of newly planted trees than in the south.

Other factors. Analysis of the returns did not bring out any very clear indications of the effect of season of planting, soil type, or presence or absence of cover. This was perhaps hardly to be hoped for; however foresters comments were of interest on certain points. There was some measure of agreement that losses were less under light shade than in the open, but under heavy shade losses were high, and in this case deaths usually occurred quite late in the season, no doubt when the transpiration

TABLE 2

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of the overwood had dried out the soil to some depth. Clay soils seem to have experienced a relatively high share of the losses, one would expect this as they are not favourable for rapid root development

HEIGHT GROWTH OF PLANTATIONS

The object in including questions on height growth was to get some idea whether big differences were apparent to the field observer, who was asked to compare the height growth of 1959 with that of 1958, classifying it merely as 'better', 'poorer' or 'much the same'. It is possible to get a fairly reliable impression of this sort from thicket stage plantation, especially in conifers with distinct nodes, but it was hardly profitable to expect useful estimates from pole stage crops.

For the thicket stage plantations the summarised returns from Conservancies have been ranked in Table 3 below, by expressing the difference between the number of reports of 'better' growth and the number of reports of 'poorer' growth as a percentage of the total number of reports. This gives some indication of the comparison between growth in 1959 and growth in 1958 as it appeared to foresters in various parts of the country. (About 70% of all returns gave growth as "much the same").

TABLE 3

Growth of thicket stage plantations in 1959 as compared with 1958

Balance of reports in favour of 1959.	
21%	North-west England Conservancy (Northern part)
19%	West Scotland Conservancy
17%	Northern Ireland
14%	South Wales Conservancy
10%	North-east England Conservancy
8%	North Wales Conservancy
3%	North-west England Conservancy (Southern part)
3%	East Scotland Conservancy
2%	South-west England Conservancy

TABLE 3 contd.....

Balance of reports in favour of 1958.	
1%	North Scotland Conservancy
6%	South Scotland Conservancy
7%	South-east England Conservancy
17%	East England Conservancy (excluding Thetford Forest)
45%	Thetford Forest

The North-west England Conservancy has been split north and south, since the rainfall during the season varied enormously between the two parts. Thetford has been considered apart from the rest of East England since reports here were concerned mainly with pines, and differ rather markedly from the general run of reports from the rest of the Conservancy.

There is a balance of opinion in favour of 'better growth', taking the country, as a whole. There seems also a fairly distinct suggestion that 'better growth' was commoner in the (normally) moister and cooler parts of the country. This is supported by numerous comments on site and the height growth and general health of species from which it seems clear that the most marked improvements were to be seen on moist sites generally, and especially on poorly draining sites.

It must be emphasised, however, that one cannot attribute the height growth made in any season wholly to the weather of that season. Trees are 'conditioned' to a greater or less extent by the weather of the previous season, and they do not all react to it in the same way. All that is being said here is that even in this unusually dry season most young plantations appear to have grown reasonably well, and that the shortage of moisture did not prevent them from doing so.

Scots and Corsican pines were the two species most commonly reported to have made poorer growth than in 1958. It is pretty certain that this was a result of the cool, moist summer of the previous year.

Older plantations. Generally speaking, returns from the questionnaire do not present any very different pattern from those for the younger plantatio Certainly no marked falling off in growth seems to have been noted over any considerable area.

For England and Wales (only) some actual measurements of annual shoot growth were available from sample trees felled in an investigation into moisture content and density of the common conifers. Current shoot length

for the 1959 growing season and the four previous internodes were measured in each sample tree. No significant differences were found between the shoot growths put on in the various seasons, which is simply to say that if there were differences, we should have required a good many more samples to spot them. For what it is worth, however, this negative result does offer some confirmation of the countrywide observations of foresters.

Plantations established under cover. The majority of reports on the growth of plantations established under cover suggest that growth of young trees under such conditions was better than usual. This seems to have been especially the case in Scotland. Norway spruce, Tsuga and Douglas fir are commonly reported to have done better than usual, but Abies species and beech do not seem to have behaved much better than in normal seasons.

WEED GROWTH IN PLANTATIONS

It was considered of interest to find out whether the summer had any very notable effects on the luxuriance of the more important types of weed vegetation. Foresters were asked to report whether weed growth was heavier, lighter or much the same as usual.

It is fairly clear from the returns that weed growth followed the major differences in the summer rainfall. As might be expected, woody vegetation showed less drought effects than herbaceous types. Bramble appeared to enjoy the hot summer over most of the country. Heather showed little change though locally it suffered from drought on shallow soils. Coppice growth appears to have been heavier than usual in the north, but not in the south..

Bracken growth seems to have been heavier than usual only in Northern Ireland and West Scotland, generally it was lighter. Herbaceous weeds were clearly less vigorous in the drier parts of the country. Growth of grasses was reported to be below normal in every conservancy except West and North Scotland, and it is perhaps worth giving a summary of the returns in this case to illustrate the reasonably close agreement between the field observations and the amount of summer rainfall in the general locality.

TABLE 4

Growth of grasses and Summer Rainfall

	Reports of heavier growth less those of lighter growth, expressed as % of all reports.	Summer Rainfall ins.
West Scotland	+ 39	19
North Scotland	+ 4	17
Dean	0	6
Northern Ireland	- 8	9
East Scotland	- 23	8
North Wales	- 30	12
South Wales	- 34	10
South Scotland	- 48	10
North-west England	- 50	8
South-west England	- 52	7
North-east England	- 56	7
South-east England	- 58	6
New Forest	- 64	7
East England	- 79	5

FIRE PROTECTION

Although no part of the original enquiry, it may be of interest to record what effect the dry summer had on the costs of fire protection and on the frequency of fires. The following figures are obtained from the Fire Protection Costs in the Statement of Accounts, and the acreages from the Annual Reports. 1958 costs have been slightly adjusted for increased labour costs in 1959.

TABLE 5

Fire Protection Costs

	Shillings per acre 1959	1958
New Forest	7.9	7.7
South Wales	7.0	7.0
South east England	5.6	4.4
North west England	5.5	3.4
South west England	4.9	5.9
North Wales	4.8	4.4
North east England	4.2	3.1
South Scotland	4.1	4.8
The Dean	3.8	4.9
East England	3.5	2.3

TABLE 5 contd.....

Fire protection Costs

	Shillings per acre	
	1959	1958
East Scotland	3.1	1.7
West Scotland	3.0	3.7
North Scotland	2.5	2.5

The mean increase in cost in 1959 was 6d per acre. On a total of 1,224,441 acres under plantations in 1959, this is an increase of £30,611. This seems a very small amount considering the character of the summer.

The following table gives the main statistics of fires for 1959 and 1958.

TABLE 6

Fires in Commission Plantations

	1959	1958
Total no. of fires in Great Britain	5600	1030
Total area burned, acres.	396	400
Total value of assessed damage	£27,149	£19,000

In retrospect, it seems a remarkable achievement to have held the total acreage burned in 1959 to the level of that in 1958; though it will be recalled that the spring of 1959 was not exceptionally dry.

MORTALITY, DISEASE AND DAMAGE IN ESTABLISHED PLANTATIONS

A number of questions were asked about drought symptoms. Some useful information was obtained on the more direct effects, especially where the symptom was readily observable. There have no doubt been many indirect effects on which little information has been obtained. In addition to the replies to the questionnaire, a number of reports and enquiries have been received by the Pathologist and the Entomologist, whose comments have been incorporated in this section.

Discolouration of needles and leaves; needle shedding etc.

Foresters were asked to report abnormal appearances of needles or le and also abnormal needle fall, and specially early autumnal effects. Generally, it is difficult to comment on the returns made, since the deg of abnormality of some of these symptoms is difficult to express. The t below shows that such symptoms were fairly widespread.

TABLE 7

Reports of needle and leaf discolouration and premature needle fall.

(a) Young crops (b) pole-stage or older

	SS		NS		SP		CP		PC		JL		DF		Ts		Be		Bi	
DISCOLORATION	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
No.forests reporting	214	146	234	147	213	155	114	77	152	79	226	151	167	113	98	56	75	39	41	43
No.forests reporting discolouration.	45	25	30	19	50	28	16	11	16	9	64	28	14	3	8	1	26	16	19	20
% age do.	21	17	13	13	23	18	14	14	11	11	28	19	8	3	8	2	35	41	46	47
NEEDLE FALL																				
No.forests reporting	311	220	366	225	315	245	178	111	233	124	249	171	258	176	151	78				
No.forests reporting premature needle fall	17	37	9	9	40	42	14	14	7	12	6	2	7	3	1	0				
% age do	5	17	2	4	13	17	8	13	3	10	2	1	3	2	1	0				

Broadly speaking, such adverse symptoms were most common in the drier Conservancies. There were frequent reports of improved appearance of spruces, these mainly referring to naturally wet or poorly drained sites.

Leaf fall in autumn seems generally to have been delayed, rather than unusually early.

Deaths from Drought

Foresters were asked to report the occurrence of deaths from drought established plantations. It is plain that losses from this cause were of low order. The table No.8. shows the number of forests reporting drought losses in the major species; all losses are included, however small the numbers concerned.

TABLE 8

Reports of Deaths of Established Trees

	SS	NS	SP	CP	PC	JL	DF	Ts	Be	Bi	SUM
No.of forests reporting	410	465	431	250	302	443	366	213	212	103	3195
No.reporting loss.	14	15	16	2	6	52	1	1	3	3	113
% with loss	3.4	3.2	3.7	.8	2.0	11.7	.3	.5	1.4	2.9	3.5%

Japanese larch clearly suffered most frequently. European larch was not included in the questionnaire, but the Pathologist had reports of a number of instances of deaths in this species also. There seems little doubt that drought symptoms are evident on Japanese larch before they appear on any other species. Where spruces are affected, needle discolouration is apt to appear towards the end of the season, followed by needle shedding and perhaps death in the subsequent spring. Hence the returns from the questionnaire do not give an entirely unbiassed picture of the situation.

Many comments were made on the relative losses in Japanese larch in 1959 compared with the previous seasons of 1955 and 1957. In Scotland it appears that losses in these two years were higher. Losses of Japanese larch were very frequently ascribed to shallow soils over rock. It may be of interest to show the relative frequency of reported losses in Japanese larch by Conservancies.

TABLE 9

Incidence of drought losses in established Japanese larch plantations

	Presence of Japanese larch reported.	Reports of loss	%
Northern Ireland	42	0	0
North Scotland	48	0	0
West Scotland	37	0	0
Dean	9	0	0
East Scotland	39	1	3
New Forest	11	1	9
SW England	29	3	10
South Wales	42	6	14
NE England	39	6	15
E. England	11	2	18

TABLE 9 contd.....

	Presence of Japanese larch reported	Reports of loss	%
N.W. England	29	6	21
South Scotland	42	9	21
North Wales	40	9	22
S.E. England	25	9	36
TOTAL	443	52	11.7%

In a number of the cases of drought damage to spruces studied by the Pathologist, it was very apparent that competition with broadleaved species greatly accentuated the effects of drought. In Rockingham Forest, young Norway spruce suffered badly when in mixture with oak, but pure crops were undamaged. In a spruce plantation near Bury St.Edmunds, dying occurred under old elm and ash on the boundaries, and not in the body of the plantation. Ride-side or edge trees were commonly affected, especially on southerly aspects.

A few reports of deaths or crown dieback of hedgerow or park trees were received, old beech thus being perhaps the most common casualties.

Bark Injuries

Death of bark on main stems, a feature often associated with dry seasons, was reported on birch, Horse chestnut, and (to a surprisingly small extent) on beech. Gumming from necrotic patches on the stems of birch was reported from many areas during the summer of 1959. Deaths were fairly numerous in some cases. Black sodden patches on the stems of horse-chestnut in the Long Walk at Windsor soon deteriorated, and in 1960 became external lesions from which the bark had fallen away.

Root Disease

Returns to the questionnaire on the incidence of root disease during and following the summer of 1959 were indeterminate. In cases observed by the Pathologist, there seemed little doubt that trees already infected by root disease deteriorated further. This was particularly the case with old hedgerow trees infected by Honey fungus and basal butt rots. At Leonardslee in Sussex, where 40-60 year old larch are badly infected by Polyporus schweinitzii and other root fungi, there was spectacular dying out during 1959, attributed to the accessory effect of the dry summer.

Stem Crack in Conifers

Previous droughts have provided many examples of stem crack in conifers, usually confined to rapidly growing species on soils of limited moisture supplying capacity. Abies nobilis has an unfavourable reputation for this failing. The season of 1959 does not however, appear to have been an unusually bad one for stem crack, to judge by the returns to the questionnaire.

The following table shows the numbers of forests reporting drought crack, (even if on one tree only).

TABLE 10

Reports of Drought crack

Northern Ireland	North Wales	South Wales	E(S)	S(S)	NE(E)	W(S)	SW(E)	E(E)	Dean	New	SE(E)	NW(E)	N(S)
9	7	6	4	4	4	3	3	3	2	2	1	0	0

The Welsh reports concerned relatively few trees in the stands, but at three forests in Northern Ireland over 30% of the trees in stands were cracked, Abies nobilis and Abies grandis being the species affected.

Details of the sites where incidence of drought crack was high in Northern Ireland are as follows:-

i) Ballycastle Forest, North Antrim. 26 yr. old Abies nobilis. Over 40% of trees affected. Mainly groups of faster growing trees. Shallow peat (up to 18") over a compacted till. Peat dried out, and subsoil is impervious. Sitka spruce on deeper peat did not suffer.

ii) Tardree Forest, South Antrim. 30 year old Abies nobilis. Severe. Dominants were affected. Good deep loam and clay over rhyolite. Even big dominants of Norway spruce in this mixture were not affected.

iii) Tollymore Park, County Down. 32 yr.old Abies nobilis. Dominants. Rather shallow free-draining soil.

iv) Knockmany Forest, E.Fermanagh. 23 yr. old Abies nobilis. 30% of the stand. 25 yr. old Abies grandis. 40% of the stand. Dominants and co-dominants. Comparatively dry, somewhat stoney slope, with porous free-draining subsoil.

v) Favour Royal Forest, E.Fermanagh. 27 yr.old Abies nobilis 50% of stand. Dominants and co-dominants. Mostly on south side of trees, cracks ½" wide.

In Great Britain, though some instances of "severe" damage were reported, most cases of drought crack affected very few trees, sometimes only one or two.

The following table gives the number of reports of drought crack by species.

TABLE 11

Number of reports of drought crack in trees

Conservancy	Sitka spruce	Norway spruce	Abies nobilis	Abies grandis	Douglas fir	Western hemlock	Corsican pine	Su
North Wales	1	4	3	1	1	1	0	11
South Wales	1	5	1	2	0	0	0	9
East Scotland	2	1	1	3	0	0	0	7
South Scotland	2	4	0	0	0	0	0	6
N.E. England	1	2	1	0	0	0	0	4
West Scotland	1	1	2	0	0	0	0	4
East England	0	3	0	0	1	0	0	4
S.W. England	1	2	0	1	0	0	0	4
New Forest	0	1	0	0	1	0	1	3
Dean Forest	0	1	0	2	0	0	0	3
S.E.England	0	1	1	0	0	0	0	2
Sum	9	25	9	9	3	1	1	57
Average age of affected trees	28	27	28	26	-	20	28	
Age limits of affected trees	20-37	18-38	21-33	18-32	-	-	-	

Norway spruce accounts for 44% of these reports of drought crack, but in view of the extensive planting of the tree and the relatively small number of cases there is no reason for any concern. Also, where drought crack of Norway spruce did occur, its incidence in the stand was usually of a low order. The following table analyses the reports in terms of the percentage of stems affected by crack in the stand.

TABLE 12

Severity of Drought Crack
Percentage of Stems affected

	Rare (less than 1%)	Moderate (1% to 10%)	Severe (over 10%)
Sitka spruce	7	1	1
Norway spruce	23	1	1
A.nobilis	3	4	2
A.grandis	4	5	0
Douglas fir	3	0	0
West.hemlock	1	0	0
Corsican pine	1	0	0
TOTAL	42	11	4

All reports of severe trouble were from North or South Wales. With about 40% of the reports, there were comments on site factors thought to be accessory. Shallow soils associated with ridges or knolls were mentioned, also rapid subsoil drainage, and proximity to road or ride sides. Eight of the sites for which returns were made had previously experienced drought crack.

An effort was made to obtain information on the incidence of drought crack amongst Abies species, the group expected on previous experience to be the worst sufferers. However, the questions posed proved ambiguous, and in any case the lowish incidence of the trouble in Britain during this season did not provide very useful data. The experience in Northern Ireland was certainly rather alarming in this particular season, and it appears that a special enquiry on drought crack in Abies is well worth undertaking, with special reference to the site characteristics which accentuate the risk. Little information was obtained comparing one Abies species with another, but a very interesting observation from Bedgebury Forest Plots in Kent recorded serious drought crack in a plot of Abies nobilis, whilst adjacent plots of A.grandis and A.lowiana of similar age remained quite unaffected.

Dutch elm Disease

There appeared to be a high incidence of elm disease in south and east England during 1960. Whether this is a direct effect of the dry summer of 1959 is not known; it is most probable that it is connected with good breeding conditions during 1959 for the beetle carrier of the disease.

Insect Pests

The only insect pest which become obstreperous was the needle midge, Cecidomyia baeri. There were many reports from south and east England of pine defoliation by this insect, and since it is a dry country lover, it seems reasonable to assume that the high 1959 populations were connected with the season. Apart from this single instance, the summer had apparently little effect on insect populations. It is in any case difficult to be sure that apparent increases in animal populations are connected with a particular season's weather. There may well be coincidence with a typical fluctuation in the numbers of the creature.

CONDITIONS IN FOREST NURSERIES

Losses from drought

Nursery foresters were asked to report on drought losses in their nurseries, classifying such losses as low (less than 10% of stock dead), moderate, (10 to 30) and severe, (over 30% dead). The following table gives the number of nurseries in each country returning the questionnaire and the number and percentage reporting any drought losses.

TABLE 13

Reports of drought losses in nurseries by countries

	Number of returns	Number reporting drought losses	Percentage reporting drought losses
Scotland	34	5	15%
N. Ireland	9	2	22%
Wales	33	11	33%
England	61	30	49%

Even in England, only about half the nurseries had any noteworthy losses at all, and it is clear that the season was by no means disastrous in any part of the country. As might be expected, the incidence of losses from drought fits fairly well with an estimate of the differences of rainfall (See Fig.3.) What losses there were occurred mainly in the transplant lines, and as foresters often commented that these happened shortly after lining out, many of them have little to do with the main drought. Some losses however, do seem attributable to the summer drought since they occurred quite late in the season.

Generally speaking, early sowings escaped the difficulties, and reports indicated that most of the losses in seedbeds could be associated with later sowings. There were however, a few cases of losses late in the summer. A few instances of damage in seedbeds appeared to be genuine examples of injury by heating of the soil, seedlings exhibiting the typical symptoms of girdling at the collar. It was observed that seedbeds disturbed by undercutting were particularly liable to drought damage.

The following table summarises the returns of losses in transplants under the species and the severity of the loss.

TABLE 14

Reports of drought loss in transplant lines by species and severity

	SS	NS	SP	CP	PC	DF	Ts	JL	EL	HL	Th	LC	Abies No.	Abies Gr.	Be	Sum
Severe	4	1	3	1	3	1	5	2	0	0	7	4	1	3	2	37
Moderate	2	2	1	0	0	3	4	3	1	3	4	2	2	0	3	30
Rare	3	2	1	1	0	1	2	1	3	1	1	1	0	0	1	18
SUM	9	5	5	2	3	5	11	6	4	4	12	7	3	3	6	

Since the species are not equally represented in all nurseries these figures are not strictly comparable; however, the rather high incidence of losses in Thuja and Tsuga suggests that these species found conditions specially difficult.

Watering was rarely undertaken. Generally it was considered unnecessary, but few nurseries reported that they had facilities for applying water on any scale.

Growth. Generally speaking the growth of nursery stock was as good as in 1959 as in 1958, except in East and South-east England. There were many comments on the unusually long sustained period of root activity, which appears to have been specially noticeable in Tsuga.

There were many comments on the excellent growth of nursery stocks of poplars, even in very dry localities. (It has been the experience in Research nurseries that poplars are excellent indicators of summer temperature).

Disease. Very little nursery disease was reported. Damping off of young seedlings and Botrytis attack on older seedlings were much less prevalent than normal. Meria was also rare. Oak mildew seems to have been slightly more prevalent than usual, and perhaps more so in the drier parts of the country.

Phenology, termination of growth.

It is doubtful whether questions on the cessation of growth in nurseries elicited anything of value. Transplants of trees such as Tsuga, Thuja and the larches, which do not have their annual shoot already differentiated in the resting bud, and are thus capable of responding to a considerable degree to the conditions of the current season, continued their height growth to a later date than usual. Sitka spruce, though not in this category, appears to have continued to grow late in Scotland and Wales, and Douglas fir is also reported as growing later than usual except in the driest areas. Scots and Corsican pine transplants are reported to have hardened off terminal buds earlier than usual. This seems likely to be a subjective judgement, influenced by the comparison with other species. Lodgepole pine transplants are said to have grown later than usual. This species is capable of making a second extension of growth under suitable conditions.

It seems fairly clear that most seedlings (with the exception of the very unresponsive Scots and Corsican pines) had a longer than normal growing season. Table 15 below summarises the returns for the whole country by species.

TABLE 15

Reports of termination of growth in seedlings and transplants, whole country.

		SP	CP	PC	EL	JL	DF	NS	SS	Ts	Th	OAK	Be
	SEEDLINGS	Percentage of Reports											
Termination of growth reported	late	18	21	22	44	47	39	24	35	32	29	14	19
	early	24	21	11	4	6	15	18	9	8	19	24	19
	TRANSPLANTS												
" " " "	late	9	7	24	38	41	28	20	30	27	26	20	13
	early	19	19	8	15	7	17	23	9	5	8	16	20

Nursery weeding

No attempt was made in the questionnaire to obtain information on the effect of the summer on nursery weed growth, since it was expected that this would be reflected in costs.

Although weeding costs over the whole country were not very different from those of 1958, the figures for England, Scotland and Wales suggest that the growth of weeds was affected by the regional variations in the summer weather of 1959.

TABLE 16

Weeding and Protection* of Seedbeds

	Industrial wages £. per 100 square yards	
	1959	1958
Scotland	3.3	2.9
Wales	4.4	5.4
England	2.0	3.3
Mean	3.0	3.4

* The protection element is small in relation to weeding cost.

There are considerable variations within countries. For instance, East Scotland Conservancy costs in 1959 are slightly lower than the (very low) figure of 1958, whereas North Scotland (with a summer rainfall in 1959 just above that of 1958 - see App.I) has higher costs in 1959 than in 1958, no doubt due to the higher temperatures and longer season of 1959. Again, in England, the greatest reduction in relative costs occurs in the North-West England Conservancy, where unit costs of seedbed weeding in 1959 are only 31% of 1958 costs; App.I shows that the southern half of this Conservancy, including many of the nurseries, was exceptionally dry. In Wales costs were only slightly less than in 1958, presumably because though in August and September the drought was affecting weed growth, yet the heavy flush of weeds in the wet and warm spring had already cost more than usual at that time of year.

Table 17 concerns transplants. These figures include the cost of sprays for weed control, and the use of machinery. Broadly, they follow the pattern of seedbed costs, though differing less from those of 1958.

TABLE 17

Weeding and Protection of Transplants

Industrial wages (adjusted), together with Machinery & 'Other'.

£. per 100 square yards

	1959	1958
Scotland	·2.9	2.6
Wales	3.8	3.5
England	2.	3.2
Mean	2.9	3.0

FLOWERING AND FRUITING OF TREES

Notably warm summers often initiate flowering in the subsequent spring and if conditions are suitable there may be heavy seed-bearing one or two seasons afterwards, depending on the time the particular fruit takes to develop. Warm summers may also affect the size of fruit and seed and the period of ripening. 1960 was not a good year for fruits or cones of most of the important tree species, and hence it is not easy to judge the direct effects of the summer in these respects. Some interesting indications were however, obtained from foresters' reports.

It was a "partial mast" year for oak. Where acorns were to be found, it was frequently reported that they were larger than usual, and ripened earlier. Sweet chestnut is reported to have ripened fruits in northern localities where this is quite unusual. Conifers coned poorly over most of the country. Scots pine had some cones. There was a tendency to smaller than normal cones in the drier parts of the country (East England, Moray Firth). There were also reports of smaller than normal cones on Corsican pine from East England. Ripening of pine cones was reported to be earlier than usual in these dry areas.

In the season of 1960, the expected heavy flowering of many tree species took place, and in the absence of severe spring frosts there was some very heavy fruiting. Most notably, it was an almost general mast year for beech and oak, the last comparable season being 1956. Fruiting in the elms was also specially abundant. Wych elm bore large quantities of seed, and viable seed was also found on hybrid elms (Ulmus glabra x carpinifolia) which is rather uncommon. The response of the conifers was less notable.

The yield of pine cones cannot yet be easily estimated * but most other species coned above normal; few, perhaps, were outstanding.

The following notes on fruiting in 1960 were prepared by Mr A.F. Mitchell from his observations throughout the country.

(i) Conifers

Abies grandis. Usually bears but few cones here, but many arboretum specimens coned fairly heavily. More than ever noted previously.

Abies nordmanniana. Normally a moderate coner. Many large specimens coned abundantly, the cones being borne on lower branches than usual also.

Abies nobilis. Not so prolific in cones as in 1956, but above average.

Araucaria araucana. Probably more cones than usual.

Chamaecyparis pisifera squarrosa. Coned sparingly in many places - possibly the first occasion on which this has been observed.

Cupressocyparis leylandii. Many cones, probably more than usual. Pollen seen, however, on trees from 48 yrs old down to 7 yrs. old. First time recorded.

Larix, spp. A good year but not outstanding. 1956 was heavier in Morayshire and probably elsewhere.

Libocedrus decurrens. Outstanding year. Trees golden with cones everywhere-normally produce few or none.

Picea abies. Some trees with remarkably densely set cones.

Picea omorika. A poor year.

Picea orientalis. Much heavier coning than usual.

Picea polita. Very heavy coning noticed for first time - occasional branches broken off, perhaps by weight of cones.

Picea sitchensis. Good year but probably not outstanding.

Picea smithiana. Very abundant coning in places.

Pinus. 1960 cones are still very small on most of these. So far noticed good crop on P.pinaster.

Pseudotsuga taxifolia. Good coning general, locally heavy. (Blank years are frequent in this species.)

Tsuga heterophylla. Heavier than normal crop on many trees.

* In fact 1961 has proved an exceptionally good year for pines.

(ii) Broadleaved trees

Acer campestris. Hedgerow trees densely covered with fruit.

Acer palmatum. Widespread and heavy fruiting.

Carpinus betulus. Extraordinarily heavy fruiting everywhere.

Castanea sativa. Good crop, but not better than that of 1956.

Fagus sylvatica. Extremely heavy crop in the south-west; good mast year generally. "Copper" beeches bearing unusually heavy crops.

Liriodendron tulipifera. Very heavy crop, but appears less than in 1957.

Nothofagus obliqua and procera. Both bearing heavy crop.

Quercus pedunculata. Heavy crop

Ulmus glabra. Exceedingly heavy crop.

SUMMARY

Over England and Wales as a whole the period from May to September was drier than in any of the last 200 years. In North and West Scotland the summer was less remarkable as in June and July there were some heavy falls of rain. In England and Wales, September was exceptionally dry, drier than any time since comparable records began in 1870.

The opportunity was taken to collect information about the more obvious effects of this season on tree growth and forest operations. This paper summarises 591 completed questionnaires, from 530 Forestry Commission forests and 61 forests in Northern Ireland.

Planting losses in England were not disastrously high as a whole, serious losses tending to be localised in regions with the most extreme drought. In most of Scotland and Wales it was a good planting season as the drought effects appeared only very late in the season.

Looking back over the past twelve seasons, some relationship appears between planting losses and the dryness of the season, but only for England and Wales, and not for Scotland.

Light overhead shade appeared beneficial for survival in the dry areas, but heavy losses occurred late in the season under dense shade. There were locally heavy losses on clay soils.

Height growth of plantations did not differ materially from that of the previous season, though in the north and west, and on poorly draining soils, it appears to have been rather better.

Grasses and herbaceous weeds were greatly reduced in vigour over large areas most affected by the drought, or on shallow soils. Woody species were less responsive. Bramble appreciated the warm conditions and grew luxuriously.

Deaths of trees from drought did not occur on any serious scale. Japanese larch was the species most often concerned, and was the first to show signs of distress. Spruces were slow to show the full effects of drought, and some deaths from drought may have been delayed till the following spring, especially of Norway spruce. There were some deaths of large hardwoods, but these were mainly over-age or unhealthy trees.

With the exception of Northern Ireland, drought crack in conifers was infrequent, and less common than in previous drought years. In Northern Ireland, there were serious cases of drought crack in Abies nobilis.

Throughout the country there were many reports of discoloration of conifer needles, mainly of Japanese larch, but also of Scots pine. It is likely some of the pine needles were affected by the needle midge Cecidomyia baeri, the only forest insect pest which became unusually numerous.

Drought losses in nurseries were not disastrous, and the incidence of loss was fairly closely related to the rainfall deficiency. Early sowing benefited from the good early spring rainfall and losses affected mainly late sowings. Growth of nursery plants was below normal in the Conservancies most affected by drought, but average or better elsewhere. Incidence of nursery disease was low. As with plantation trees, so in the nurseries species capable of late growth benefited from the unusually prolonged summer. Unit weeding costs were generally less than in the wet year of 1958.

1959 was not itself a good year for flowering of forest trees. What acorns there were tended to be larger than normal, and Sweet chestnut fruits ripened in northern districts where this rarely happens. Cones were smaller than usual in the drier parts of the country. The summer of 1959 encouraged profuse flowering of many species in the spring of 1960, which proved a general mast year for beech and oak. A number of conifers coned heavily, including some species whose coning is rare in this country. The season of 1961 will be a good cone year for the pines, notably Scots and Corsican.

APPENDIX I.

Rainfall in 1959 and 1958

Monthly totals, April - Sept., by Conservancies

CONSERVANCY	YEAR	APRIL	MAY	JUNE	JULY	AUGUST	SEPT.	SU
NORTH SCOTLAND	1959	3.9	1.5	2.8	5.6	3.1	2.2	19.
	1958	2.6	4.5	2.0	2.6	4.0	2.4	18.
Driest area was Nairn	1959	2.3	0.6	1.9	2.2	0.8	0.6	8.
	1958	1.4	2.5	2.2	3.3	3.7	1.6	14.
WEST SCOTLAND	1959	5.3	1.7	3.4	6.4	3.5	1.6	21.
	1958	2.4	4.3	3.7	5.5	6.5	5.7	28.
EAST SCOTLAND	1959	2.5	1.0	2.4	2.9	1.0	0.7	10.
	1958	1.7	3.4	2.6	5.3	3.8	2.6	19.
Driest area was Fife	1959	2.6	0.6	2.2	3.2	0.6	0.6	9.
	1958	1.9	4.9	2.6	5.3	3.6	1.9	20.
SOUTH SCOTLAND	1959	2.9	1.2	2.7	3.1	0.7	1.2	11.8
	1958	1.7	3.0	3.3	5.0	3.9	3.9	20.8
Driest area was East Lothian.	1959	1.4	0.4	1.9	1.9	0.4	0.5	6.5
	1958	2.2	1.9	2.7	4.8	2.5	2.2	16.3
NORTHERN IRELAND	1959	2.6	1.3	2.1	3.5	1.0	1.5	12.0
	1958	1.5	2.8	5.2	4.8	4.1	3.9	22.3
NORTH WALES	1959	4.8	1.9	3.3	4.8	1.2	0.6	16.6
	1958	1.9	4.6	4.3	5.7	4.3	8.7	29.5
Driest area was Radnor	1959	3.9	2.4	4.4	3.8	0.5	0.2	15.2
	1958	0.9	2.8	3.7	4.9	3.0	6.7	22.0
SOUTH WALES	1959	4.0	1.8	2.3	3.5	1.7	0.3	13.6
	1958	1.0	3.9	3.9	4.2	4.3	7.7	25.0
NORTH-WEST ENGLAND (a) Northern half	1959	3.9	2.0	4.2	4.2	0.7	0.9	15.9
	1958	1.7	4.8	3.9	4.3	4.7	6.3	25.7
(b) Southern half	1959	2.9	0.9	1.2	1.7	1.0	0.1	7.8
	1958	0.8	2.4	4.8	4.2	3.1	3.7	19.0
Driest area was Leicestershire	1959	1.8	0.4	0.4	2.0	0.8	0.0	5.4
	1958	0.5	2.0	4.6	2.2	2.3	1.3	12.9
NORTH-EAST ENGLAND	1959	2.8	0.8	2.5	1.8	0.6	0.6	9.1
	1958	1.5	3.6	3.5	3.6	2.8	3.0	18.0
EAST ENGLAND	1959	1.9	0.6	1.0	2.4	1.0	0.1	7.0
	1958	0.9	2.2	4.7	2.9	2.8	2.8	16.3

APPENDIX I contd.....

	YEAR	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	SUM
Driest area was Huntingdonshire	1959	1.1	0.4	0.5	1.6	0.5	0.0	4.1
	1958	0.7	2.0	5.2	1.6	3.7	2.4	15.6
SOUTH-EAST ENGLAND	1959	2.5	0.7	0.9	2.3	1.6	0.2	8.2
	1958	1.1	2.3	3.7	2.0	3.9	4.2	17.2
NEW FOREST	1959	2.4	0.6	0.9	2.2	2.0	0.2	8.5
	1958	0.7	2.3	3.6	1.9	3.3	4.5	16.3
FOREST OF DEAN	1959	3.2	1.0	1.5	2.3	1.2	0.2	9.4
	1958	0.6	2.8	4.1	2.9	3.0	7.0	20.4
SOUTH-WEST ENGLAND	1959	3.1	1.2	1.1	1.8	2.3	0.2	9.7
	1958	0.8	2.9	4.0	2.8	3.8	5.1	19.4
Driest area was Hereford	1959	2.6	1.2	0.9	2.2	0.8	0.2	7.9
	1958	0.5	2.3	3.6	3.0	2.0	6.8	18.2

(Note: Conservancy rainfall here is the mean of the rainfall of the counties contained in each Conservancy. No adjustment for altitude has been made.)

APPENDIX II

SUMMER RAINFALL AND POTENTIAL EVAPORATION BY COUNTIES AND CONSERVANCIES

(Note: As some order must be chosen for Conservancies, we have chosen that used in the section on growth of plantations.)

		Total May to Sept rainfall. Inches.			Estimate of potential evaporation May to Sept Inches		MEAN DAILY MAX. TEMP May-Sept. 1959 less 1958 degrees F.
		1959	1958	1916-1950	1959	1958	
West Scotland	Perth	15.7	30.5	25.2	12.8	11.2	
	Stirling	13.5	23.0	21.1	13.6	12.7	
	Argyll	20.4	23.6	27.4	12.8	12.3	
Conservancy: weighted mean		18.7	24.7	26.0	12.9	12.1	+ 1.3
Northern Ireland							
	Londonderry	9.1	20.2	19.7			
	Antrim	9.6	21.0	17.4			
	County Down	9.7	23.7	14.6	not		
	Armagh	9.2	20.3	14.4	available		
	Tyrone	8.0	-	16.9			
	Fermanagh	10.7	-	19.9			
Country: weighted mean		9.4	21.3	18.1	(exc: Tyrone & Fermanagh)		+ 1.8
South Wales	Cardigan	6.4	23.2	19.3	16.0	12.9	
	Pembroke	7.6	26.4	16.7	17.5	13.4	
	Carmarthen	-	-	23.2	16.6	13.6	
	Brecon	12.0	32.7	23.6	16.0	13.1	
	Glamorgan	10.2	18.4	22.3	17.0	14.5	
	Monmouth	9.8	22.4	16.8	16.6	13.9	
Conservancy: weighted mean		10.1	24.3	20.8	16.6	13.7	+ 2.0
North-west England							
	Cumberland	11.0	22.8	21.8	15.5	13.2	
	Westmorland	16.8	28.6	26.6	15.6	13.3	
	W. Yorkshire	14.6	27.6	17.4	16.0	13.0	
	Cheshire	9.2	17.2	12.9	16.8	14.2	
Northern part: weighted mean		14.2	24.4	21.8	15.6	13.3	+ 1.7
	Derbyshire	5.7	23.2	17.9	16.0	13.2	
	Nottingham-shire	3.7	18.0	10.7	16.4	13.5	

		Total May to Sept rainfall. inches			Estimate of potential evaporation May to Sept Inches		MEAN DAILY MAX. TEMP May-Sept. 1959 less 1958 degrees F.
		1959	1958	1916-1950	1959	1958	
	Warwickshire	5.7	15.9	11.2	16.7	13.8	
	Leicestershire	3.7	12.4	11.2	16.0	13.0	
	Staffordshire	4.2	18.9	11.8	16.2	13.3	
	Shropshire	5.8	20.9	12.0	16.8	13.8	
Southern part:	weighted mean	4.8	18.2	12.0	16.4	13.5	+ 2.2
North-east England							
	Northumberland	7.9	17.4	13.8	13.9	12.8	
	West Yorkshire	5.6	19.5	15.6	15.8	13.0	
	Durham County	6.7	15.3	13.1	14.8	13.1	
	N & E. Yorks	5.0	13.7	12.6	16.0	13.2	
Conservancy:	weighted mean	6.6	14.9	13.7	14.9	13.0	+ 2.1
North Wales	Caernarvon	10.6	30.4	25.1	16.5	13.2	
	Denbigh	8.5	19.2	16.0	16.6	13.6	
	Merioneth	15.2	34.9	24.2	16.2	13.4	
	Montgomery	14.6	30.3	16.5	16.0	13.1	
	Cardigan	8.3	25.6	19.3	16.0	12.9	
	Radnor	11.3	21.0	22.1	15.9	13.0	
Conservancy:	weighted mean	11.9	28.1	20.7	16.3	13.3	+ 2.0
East Scotland	Moray	6.3	13.8	13.3)	13.5	13.3	
	Banff	8.2	17.0	15.6)			
	Aberdeenshire	6.8	16.9	13.5)			
	Kincardine	9.7	22.5	-)			
	Angus	8.3	17.4	14.2)	12.6	11.7	
	Fife	7.2	18.3	13.7)			
	Perth	9.6	18.2	17.0	13.3	13.0	
Conservancy:	weighted mean	8.0	17.5	14.8	13.2	12.7	+ 2.4
South-west England							
	Somerset	6.0	16.2	14.7	16.9	14.3	
	Dorset	6.2	16.6	12.2	18.2	15.6	
	Devon	7.7	24.6	18.5	17.5	14.0	
	Cornwall	11.3	26.3	16.9	17.7	14.2	
	Wiltshire	5.6	15.3	11.9	16.9	14.0	
	Worcestershire	5.3	16.0	11.9	16.8	14.0	

	Total May to Sept rainfall. inches.			Estimate of potential evaporation May to Sept Inches		MEAN DAILY MAX. TEMP May-Sept. 1959 less 1958 degrees F.
	1959	1958	1916-1950	1959	1958	
Hereford	5.3	17.6	11.6	17.0	14.4	
Gloucestershire	5.2	16.2	11.6	17.2	14.1	
Conservancy: weighted mean	7.0	19.6	14.9	17.4	14.4	+ 2.1
North Scotland						
Caithness	8.7	10.3	12.9	11.7	11.5	
Sutherland	12.6	14.9	30.0	12.2	12.1	
Ross	30.3	21.3	22.0	11.9	12.2	
Cromarty	8.9	14.0		13.5	13.3	
Inverness	15.0	18.7	21.9	12.7	11.8	
Rhum	34.6	24.8	24.9	-	-	
Tiree	12.2	15.1		-	-	
Nairn	6.0	13.3	14.5	-	-	
Conservancy: weighted mean	16.6	17.7	21.8	12.6	12.1	+ 1.2
South Scotland						
Mid Lothian	6.5	17.9	14.8	13.4	13.0	
East Lothian	5.2	14.1	12.2	13.4	12.6	
Berwickshire	5.1	15.2	12.7	13.6	12.6	
Peebleshire	8.8	18.4	18.5	13.2	12.5	
Roxburghshire	7.8	20.2	12.6	13.3	12.6	
Lanarkshire	12.6	23.0	14.6	13.2	12.6	
Dumfriesshire	13.2	25.5	20.6	13.9	12.4	
Kirkcudbrightshire	11.7	23.9	19.4	14.9	12.8	
Wigtownshire	6.8	15.6	15.4	15.1	13.1	
Ayrshire	10.3	17.7	18.2	14.8	14.0	
Conservancy: weighted mean	9.9	20.5	17.4	14.1	12.8	+ 1.9
The Dean	6.1	19.8	-	16.8	13.9	+ 1.8
South-east England						
Kent	5.3	16.7	10.8	18.7	15.0	
Surrey	5.5	15.4	10.9	18.8	15.4	
Sussex	4.9	17.0	12.0	18.6	14.6	
Hampshire	6.8	16.0	11.3	18.1	14.7	
Berkshire	5.8	15.2	10.3	17.4	13.6	
Conservancy: weighted mean	5.7	16.4	11.4	18.4	14.7	+ 2.3

APPENDIX II contd .....

		Total May to Sept rainfall. inches.			Estimate of potential evaporation May to Sept Inches		MEAN DAILY MAX. TEMP May-Sept. 1959 less 1958 degrees F.
		1959	1958	1916-1950	1959	1958	
New Forest		6.6	15.7	10.7	19.0	16.0	+ 2.3
East England	Hertfordshire	7.0	15.8	9.9	17.7	14.3	
	Buckinghamshire	6.8	15.1	11.2	17.6	13.8	
	Norfolk	6.2	14.8	10.7	17.4	14.5	
	Suffolk	4.5	14.7	10.1	17.7	14.8	
	Essex	4.2	17.6	9.5	17.4	14.4	
	Bedfordshire	5.4	15.0	10.7	17.4	14.4	
	Huntingdonshire	3.1	15.0	9.4	16.7	13.6	
	Northampton-shire	3.8	14.6	10.1	17.0	13.8	
	Lincolnshire	4.1	14.5	10.4	16.8	13.7	
Conservancy:	weighted mean	5.3	14.9	10.4	17.3	14.8	+ 1.9

APPENDIX III

GROWING-SEASON RAINFALL AS PERCENTAGE OF NORMAL

1948 - 1959.

		March	April	May	June	July	August	Sept.
		%						
ENGLAND AND WALES	1948	54	96	117	151	62	134	113
	1949	65	121	113	30	68	64	79
	1950	60	135	90	77	137	147	196
	1951	175	135	140	55	67	156	141
	1952	116	109	113	86	47	124	149
	1953	40	138	109	98	135	99	125
	1954	117	29	131	142	124	139	139
	1955	83	65	179	143	37	34	80
	1956	46	75	41	110	137	179	146
	1957	102	19	83	79	144	121	196
	1958	83	51	132	202	117	123	158
	1959	114	130	44	81	83	44	11
SCOTLAND	1948	88	115	77	181	102	159	156
	1949	77	151	91	59	65	113	74
	1950	94	150	66	123	133	115	257
	1951	95	150	63	85	116	125	87
	1952	95	78	90	130	80	114	98
	1953	38	118	108	87	147	91	139
	1954	89	65	157	143	106	102	156
	1955	50	76	112	87	37	30	115
	1956	59	69	96	117	160	151	131
	1957	115	60	74	100	152	128	98
	1958	86	77	132	102	120	113	93
	1959	91	125	53	112	122	51	37

Note: Normal rainfall for the period March to September inclusive, for the years 1881-1915, was:

England & Wales	15.6"
Scotland	21.6"
Northern Ireland	20.4"